LAW OFFICE OF
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August 22, 2013

RECEIVED
AUG 2 2 2013
Utah Division of Water Quality

By email (keagan@utah.gov) and Hand Delivery
Keith Eagan
Utah Division of Water Quality
Groundwater Protection Unit
195 North 1950 West
Salt Lake City, Utah

Re: Comments on Sunnyside Cogeneration Associates
Groundwater Discharge Permit No. UGW070002

Dear Mr. Eagan:

On behalf of HEAL Utah, 824 S 400 W #B-111, Salt Lake City, UT 84101, I submit the following comments on the above-referenced permit.

Background

The Sunnyside cogeneration facility is a coal-fired power plant located in Carbon County, Utah that produces approximately 51 mw net of electricity. The primary fuel stock for the plant is coal refuse material that resulted from the operation of two large underground coal mines which operated for nearly a century. The plant's total life expectancy is 30 years. It appears that the facility first began operating in 1992. Burning the waste coal generates approximately 800 to 1000 tons per day of ash.

The ash will be trucked to a disposal site SCA #1 Ash Landfill in the NW 1/4, Sec. 12, T. 15 S., R. 13 E., SLBM, or SCA #2 Ash Landfill in the NW 1⁄4 Sec 8 and NE 1⁄4 Sec 7, T. 15S., R. 14 E., SLBM, both approximately one mile from the power plant. The ash generated from the facility is currently excluded from the definition of solid waste and therefore no solid waste permit is required for these sites. However, EPA has issued a proposed rule to potentially reclassify coal ash as subject to regulation under the Resource Conservation and Recovery Act ("RCRA").

The SCA #1 site is located along a steeply sloping escarpment that faces south to southeast and terminates in a relatively flat area along Icelander Creek. The SCA #2 site is located at the head of a small side canyon facing the west. The SCA #1 Ash Landfill is an unlined landfill comprised of three phases on approximately 75 acres. It has been under construction since the early 1990's.

The existing SCA #1 Ash Landfill Phase I is an unlined disposal landfill. Ash is placed in cells in a terrace-and-bench configuration. The existing SCA #1 Ash Landfill Phase 1 encompasses approximately 15 acres. Phase I was closed in 1998, capped and re-seeded according to approved specifications.

SCA #1 Ash Landfill Phase II is located immediately west of the Closed SCA #1 Ash Landfill Phase I. Phase II has been developed over a ten-year period, and encompasses approximately 32 acres of land. Phase II was completed in 2008. Phase II is not in final closure. Phase II is nearing the end and will be closed like phase I. The permit does not state whether this is a lined or unlined structure.

SCA #1 Ash Landfill Phase III is to be located immediately west of the Closed SCA #1 Ash Landfill Phase I and east of the Phase II landfill. Phase III will be developed over a fifteen-year period is expected to be completed in 2013 and will encompass approximately 30 acres. The permit does not state whether this is a lined or unlined structure.

The SCA#2 Ash Landfill is to be located approximately one mile to the southeast from the SCA power plant facility and approximately 1.5 miles east of the SCA #1 Ash Landfill. It is proposed to begin construction in 2013 with ash placement in approximately 2015. SCA#2 Ash Landfill will be constructed in a terrace and bench configuration with a footprint of approximately 34 acres, plus surrounding access and drainage facilities. Terraces will be a maximum of 60 feet high with approximately 3 horizontal to 1 vertical faces. Each terrace will be set back 15 feet from the previous terrace to form a bench. The permit does not state whether this is a lined or unlined structure.

Comments

1. It is unclear whether any true "background" water quality data exists prior to the commencement of operations of the coal plant ash disposal. The permit map shows extensive industrial activities upgradient of the proposed landfill expansion site, including a tailings pond and coke ovens. Groundwater protection levels for TDS are based on "background" conditions. Thus, if the groundwater in SCA#1 Phase III or SCA #2 has already been affected by previous human activities, the groundwater protection standards may not be truly protective of natural conditions. Please make available to the public all background water quality data, the location and date of all such samples, and results.

2. It is unclear whether SCA #1 Phase III and SCA #2 are lined landfills or whether they would comply with design specifications that are likely to result from EPA's new coal ash rulemaking. Please indicate to the public whether the design of this landfill would comply with EPA's proposed rule on coal ash disposal. 75 Fed. Reg. 35128.

3. Although there is a groundwater protection standard for total dissolved solids, there is no specific monitoring and reporting requirement for TDS in the draft permit. Please add at least a monthly specific monitoring and reporting requirement for TDS.

4. A technical review of the draft permit was conducted by Steve Nelson. A copy of his report is attached hereto and incorporated herein by reference. It is Mr. Nelson's professional opinion that a coal ash landfill should not be located in the proposed location. More specifically, Mr. Nelson states,

- SCA-1 should not, in my opinion, have been constructed in its current location. There are plenty of flat, pediment surfaces away from active drainage systems that could have accommodated this coal ash. It should never have been constructed into the cliff of an active drainage system. As it is, SCA-1 is vulnerable to flooding and permanent reorganization of the drainage network by stream capture. This could result in direct dispersal of coal ash during surface water flows similar to a 100-year event, as well as undercutting down-slope areas of the landfill before, during or after diversion. There is also likely to be increased seepage from diverted underflow from Grass Trail Creek flowing beneath the east end of the pile. These processes may combine to undermine the slope stability of the landfill. Even if none of this were to occur, because SCA-1 is perched on a cliff it will eventually be eroded and transported into the Green River—Colorado River system. Although no landfill can be considered a "permanent" feature, the permit should be disqualified on geologic considerations.

Mr. Nelson also has significant concerns with regard to the documentation supporting the application. See attached.

Thank you for the opportunity to submit comments on the above-referenced draft permit. We request that the permit application be denied. In the alternative, we request that UDWQ address the numerous concerns outlined in these comments and reissue a new draft permit for public review.

If you have any questions, don't hesitate to contact me.

Sincerely,

s/ John Barth

cc: Christopher Thomas, Executive Director, HEAL Utah

Evaluation of the Sunnyside Cogeneration Associates Draft Groundwater Discharge Permit

Stephen T. Nelson

Introduction

This report represents my review of available documentation regarding the draft groundwater discharge permit UGW570002 by the Utah Division of Water Quality, and perhaps more importantly, geological considerations regarding this permit. The application deals with the disposal of coal ash generated from the Sunnyside Cogeneration Associates (SCA) power plant in Carbon County, Utah. In compiling this report I have highlighted deficiencies in documentation, as well as unfavorable site conditions.

The report is organized as follows. For context, a brief description of relevant local and regional geology is provided in detailing surface and subsurface hydrogeological vulnerabilities of the site. Following this, comments on the shortcomings in the documentation are provided. A copy of my resume is attached hereto.

Documents Reviewed

Draft Groundwater Discharge Permit UGW57002, July 23, 2013 version

Statement of Basis Sunnyside Cogeneration Associates Ash Landfills, Modification of Ground Water Discharge Permit UGW070002, July 23, 2013 version

Water Quality Sampling and Analysis Plan & Ash Leachate Analysis Plan: Phase I, II, III Ash Disposal Facility Permit No. UGW070002, Revised Feb. 2, 2009

Leachate Analysis, Sunnyside Cogeneration Associates, Feb. 17, 2011

Information Reviewed

- Field inspection Aug. 19, 2013
- Orthophoto imagery obtained from: http://gis.utah.gov/data/
- Stream, road, municipality shapefiles from: http://gis.utah.gov/data/
- NED data (i.e., digital topography) obtained from: http://viewer.nationalmap.gov/viewer/
- Hill slope data calculated form NED information
- Site imagery and elevation profile from Google Earth
- 100-year FEMA floodplains were obtained and digitized from: https://msc.fema.gov/webapp/wcs/stores/servlet/mapstore/homepage/MapSearch

Methodology

Geospatial information was projected and visualized using ESRI software ArcMap v. 10. This information is shown in Figures 1, 2, 4, and 5. In addition to projection and visualization, ArcMap software was used to calculate and project slopes shown in Figure 5. Google earth and its elevation profile tool were used to generate Figure 2. Insight gained from the site inspection[1] contributed greatly to the interpretation of the information in this report.

Summary

The disposal of coal ash at the SCA facilities is problematic. Of the two disposal areas, SCA-2 is too poorly located to evaluate and SCA-1 is vulnerable to disturbances and releases based on geologic conditions, including natural modification of surface water drainages, groundwater flow, and slope instability. On this basis, SCA-1 should be disqualified as a landfill for coal ash. Documentation surrounding the draft permit is incomplete and confusing. Proper review of the proposed action cannot be accomplished until the documentation is updated.

Geological Setting

Figure 1 shows the location of coal ash disposal area SCA-1. SCA-2 is not shown because it has not been constructed and its location under the township and range system is too imprecise to evaluate (see below), although it apparently is intended to lie 2 to 3 km east of SCA-1.

Current disposal in SCA-1 occurs on the south-facing slope of a large east-west oriented cliff that marks the southern margin of a large pediment surface extending westward from the base of the Book Cliffs. This surface is armored by alluvium and other debris that overlie the soft Blue Gate Member of the Mancos Shale. This armored pediment surface protects and "holds up" the underlying shale.

A very large drainage basin in the Book Cliffs feeds a stream system known as Grass Trail Creek that flows through the towns of Sunnyside and East Carbon, Utah. It is expected that periodic heavy precipitation events or rapid spring snowmelt could result in large surface water flows or perhaps even debris flows through the area. Note the proximity of Grass Trail Creek to the cliff and SCA-1 in particular (Figs 1 & 2). The implications of this proximity are discussed below.

Drainages south of the cliff can be extensive and extend eastward into the Book Cliffs. However, in the vicinity of SCA-1 they do not drain areas that approach the size of the Grass Trail Creek drainage. The reader should note that all of these stream systems are integrated with the Green River—Colorado River drainage basins.

Surface Hydrogeology

The stream network in the vicinity of SCA-1 causes me considerable concern. Figure 2 illustrates the FEMA 100-year floodplain along Grass Trail Creek just north of the landfill. At point A (Fig. 2) the floodplain is within about 70 meters of Drainage B. Figure 3 further illustrates that, within the resolution of Google Earth data, there is little by way of a topographic barrier to flood waters being diverted into Drainage B in this area (Fig. 3).

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[1] See the appendix.

Stream capture or stream piracy is a well-known phenomenon by which drainage networks are modified by capturing flows of one system and diverting them into another. A significant stream flow/flood event at or upstream of point A (Fig. 2) could divert flows from Grass Trail Creek, and its entire collection system, into the stream networks south of the cliff, and do so permanently. Were such an event to occur at point A, high stream flows would inevitably, and directly, impact the integrity of the pile. Were Grass Trail Creek captured at or any point up gradient from point A, high flow events might compromise the southern (and down-slope) side of the pile via widening and down cutting of the channel. Given the proximity of Drainage B and Grass Trail Creek, diversion of the latter stream south of the cliff seems likely if not inevitable in the near geologic future[2]. It appears as if a 100-year flood event may approach diversion.

Subsurface Hydrogeology

There may be a lot of uncertainty as to the regional groundwater flow system, or lack thereof, given the low permeability of the Blue Gate Member of the Mancos Shale. However, some conclusions can be drawn relative to shallow flow systems that underlie alluvial material beneath streams in the immediate vicinity of SCA-1.

Underflow (i.e., shallow groundwater flow in alluvium parallel to the overlying stream) beneath Grass Trail Creek is clearly being partially diverted at point A down the cliff face and into the drainage south of SCA-1 (Fig. 4). This is evidenced by phreatophytes (e.g., willows, marsh grasses, etc.) growing along in the cliff face, as well as mapped seeps and springs. Furthermore, this flow system is clearly impacting (bringing water into or beneath?) the eastern end of SCA-1. Phreatophytes and seeps mapped by SCA (see map in Sample Analysis Plan) indicate that there is an active flow system to receive seepage from the pile and to transport it further down gradient.

If piracy of Grass Trail Creek were to occur, all of its underflow may be diverted along and beneath the stream network to the east and south of SCA-1. In other words, the broad, verdant riparian zone along Grass Trail Creek in the town of East Carbon north of SCA-1 (Fig. 4) may be abandoned and reestablished south of the SCA-1 piles, yet becoming vulnerable to seepage from the landfill.

Slope Stability

As mentioned above, SCA-1 is largely built into a south-facing cliff, which is in places quite steep (e.g., Fig. 1). Figure 5 indicates that the slopes of the cliff in the vicinity of SCA-1 commonly exceed 20 to 25°. When coupled with surface and groundwater flow discussed above, the wisdom of building this facility into the cliff face comes into question. Loading of groundwater into the east end of SCA-1, erosion of the pile by stream piracy, or undercutting of the pile by present or diverted stream flows to the south of the pile may make this facility vulnerable to slope failure.

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[2] Geologists have a concept of time that may be foreign to the layperson. "Near geologic future" might mean anything from tomorrow to a few tens of thousands of years.

Even if none of the above phenomena were to occur, SCA-1 is emplaced into the side of an actively eroding cliff. The natural processes of headward erosion and slope retreat by rivulets actively attacking the cliff walls will ensure that coal ash will be eroded and dispersed by the stream system at some point in the future.

Draft Groundwater Discharge Permit

- SCA-2 is located far too imprecisely to evaluate its suitability. The two quarter sections given as a location equate to an uncertainty of about ½ mile in an east-west direction and ¼ mile north-south. The cited values of 110° 22' W. Long. & 39° 32' N Lat. place the landfill in the Book Cliffs. We had no opportunity to inspect the March 2013 drawing for this feature.
- MW-8 may not be an appropriate choice for background values for SCA-2. It is located near SCA-1, not SCA-2. It is also immediately south of a bare patch, raising questions as to whether it has been affected by human activity. I am concerned that this may set the bar too low for groundwater protection.
- The public has no way of knowing exactly where phase II of SCA-1 is. No map or more exact coordinates are provided and we were not able to inspect the "February 8, 1997" drawings. And, what does "additional expansion of the landfill will also incorporate referenced design specification" mean? There really should be a good map(s) in this permit that the public can use to spatially assess permit criteria.
- The public has no way of knowing exactly where phase III of SCA-1 is to be located. No map or more exact coordinates are provided and we were not able to inspect the "December 23, 2003" drawings.
- The location, and therefore suitability, of monitoring wells is not provided in the draft permit. I was able to locate a landfill expansion map in the Sampling Plan. However, this map is difficult to read. Topographic contours cannot be separated from streams. Labels for springs, seeps and wells are difficult to read. Furthermore, this map is NOT GEOREFERENCED to any common coordinate system that the public can use to locate these features. In addition, MW-7 (down gradient monitoring point) and Whitmore Spring are not identified. How can these features be designated as monitoring points if they are not geographically located anywhere in the permit?
- MW-8 is cited as a down gradient monitoring point on Drawing 5 for SCA-2. Where is Drawing 5?
- In this case, monitoring for only 10 years after final closure is inadequate. We know that leachate from these piles is chemically aggressive (pH=12.3; leachate analysis) with a very high TDS.

Sampling Plan

- As above, Whitmore Springs is not located on any map, nor is the "Fresh Water Reservoir."
- There is an inconsistency between cited existing monitoring wells and the map. MW-1, -2, -3, -4, and -7 are cited as existing wells. There is no MW-6 on the map, but there is an MW-5 and MW-8. As noted above, MW-7 is missing from the map.

- Appendices are cited but not made available for inspection.

Statement of Basis

- "Because MW-1 is probably not in a location that can directly evaluate impacts from the landfill, the permittee replaced MW-1 with MW-4 in 1997 adjacent to the existing SCA # 1 Ash Landfill and MW-7 which is adjacent to sediment pond #017." This text is provided in connection with an out of compliance condition for MW-1. Taking this discussion at face value, the public still does not know the location of MW-7 or sediment pond #017.
- "In preparation for the SCA # 1 Ash Landfill Phase III, Sand Blanket drains were installed over two identified seasonal seeps to facilitate drainage and to prevent up take by the ash-fill material. One seep is under the Phase III landfill footprint; the other seep is just outside the footprint." Where are these features documented? Where are they on the land surface?
- Under the section on compliance there is discussion of exceedances for Pb and Se, discussed "per item F. above." Where is this discussion? Where is item F?

Conclusions

- SCA-1 should not, in my opinion, have been constructed in its current location. There are plenty of flat, pediment surfaces away from active drainage systems that could have accommodated this coal ash. It should never have been constructed into the cliff of an active drainage system. As it is, SCA-1 is vulnerable to flooding and permanent reorganization of the drainage network by stream capture. This could result in direct dispersal of coal ash during surface water flows similar to a 100-year event, as well as undercutting down-slope areas of the landfill before, during or after diversion. There is also likely to be increased seepage from diverted underflow from Grass Trail Creek flowing beneath the east end of the pile. These processes may combine to undermine the slope stability of the landfill. Even if none of this were to occur, because SCA-1 is perched on a cliff it will eventually be eroded and transported into the Green River—Colorado River system. Although no landfill can be considered a "permanent" feature, the permit should be disqualified on geologic considerations.
- As detailed above, there are a host of problems with documentation (or lack thereof) in the Draft Permit, the Sampling Plan, and the Statement of Basis. The public has not been provided with adequate information to judge the acceptability of the Draft Permit.

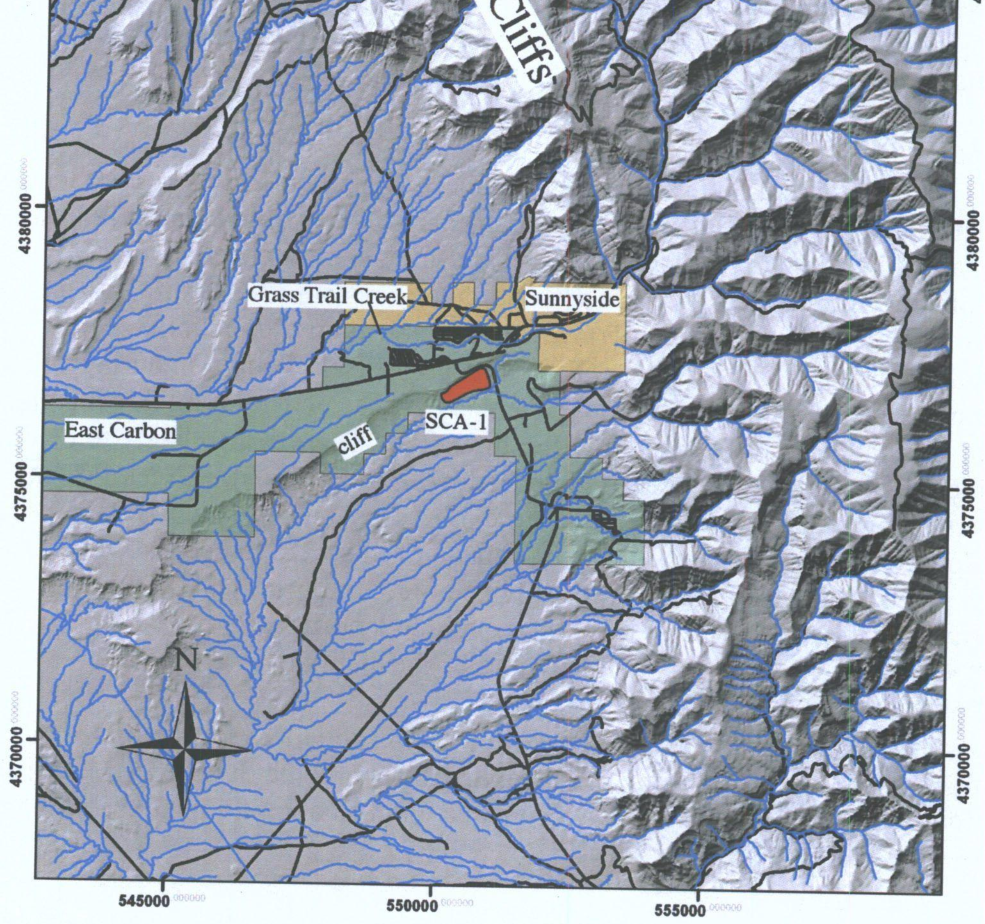

Figure 1. Index map of the Sunnyside Cogeneration geographic setting. Disposal area SCA-1 is shown in red. Black lines show roads and blue lines drainages (data from Utah Automated Geographic Reference Center, http://gis.utah.gov/data/) superimposed upon a hillshade generated from topographic data obtained from the US Geological Survey (http://viewer.nationalmap.gov/viewer/). Perimeter ticks represent positions and distances in meters (UTM projection NAD83, Zone 12S).

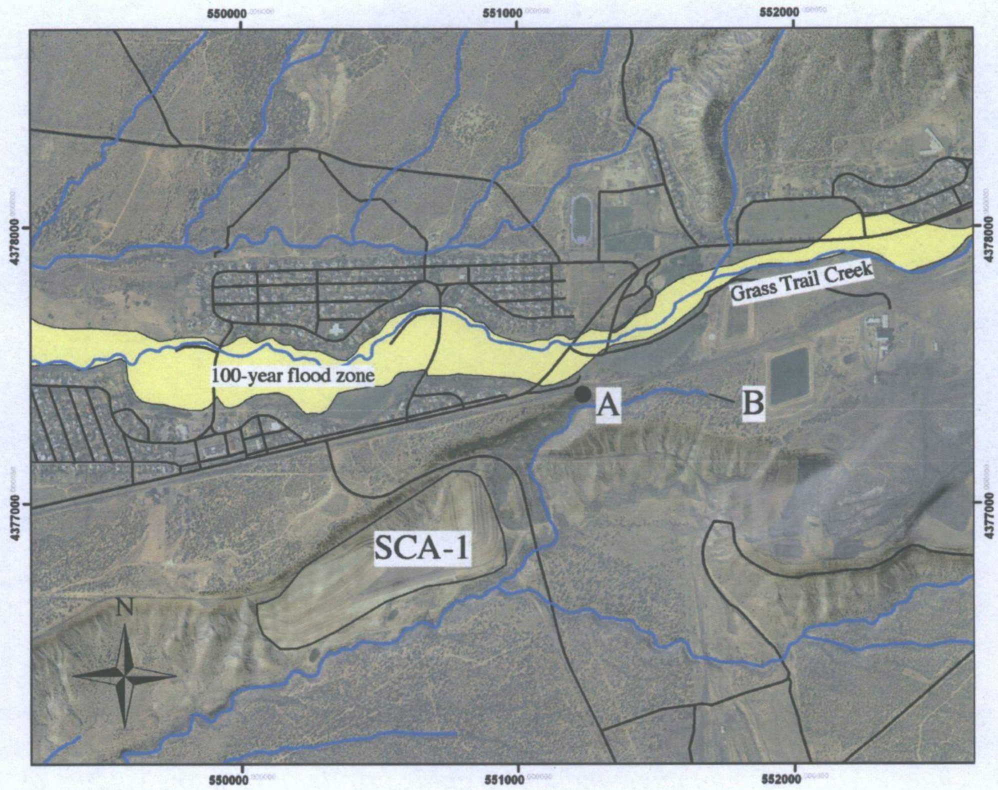

Figure 2. Map of SCA-1 relative to surface drainages and a selected FEMA 100-year flood plains (yellow) digitized from https://msc.fema.gov/webapp/wcs/stores/servlet/mapstore/homepage/MapSearch.html. Black lines show roads and blue lines drainages (data from Utah Automated Geographic Reference Center, http://gis.utah.gov/data/) with orthoimagery (http://gis.utah.gov/data/) superimposed upon a hillshade generated from NED data (http://viewer.nationalmap.gov/viewer/). Perimeter ticks represent positions and distances in meters (UTM projection NAD83, Zone 12S).

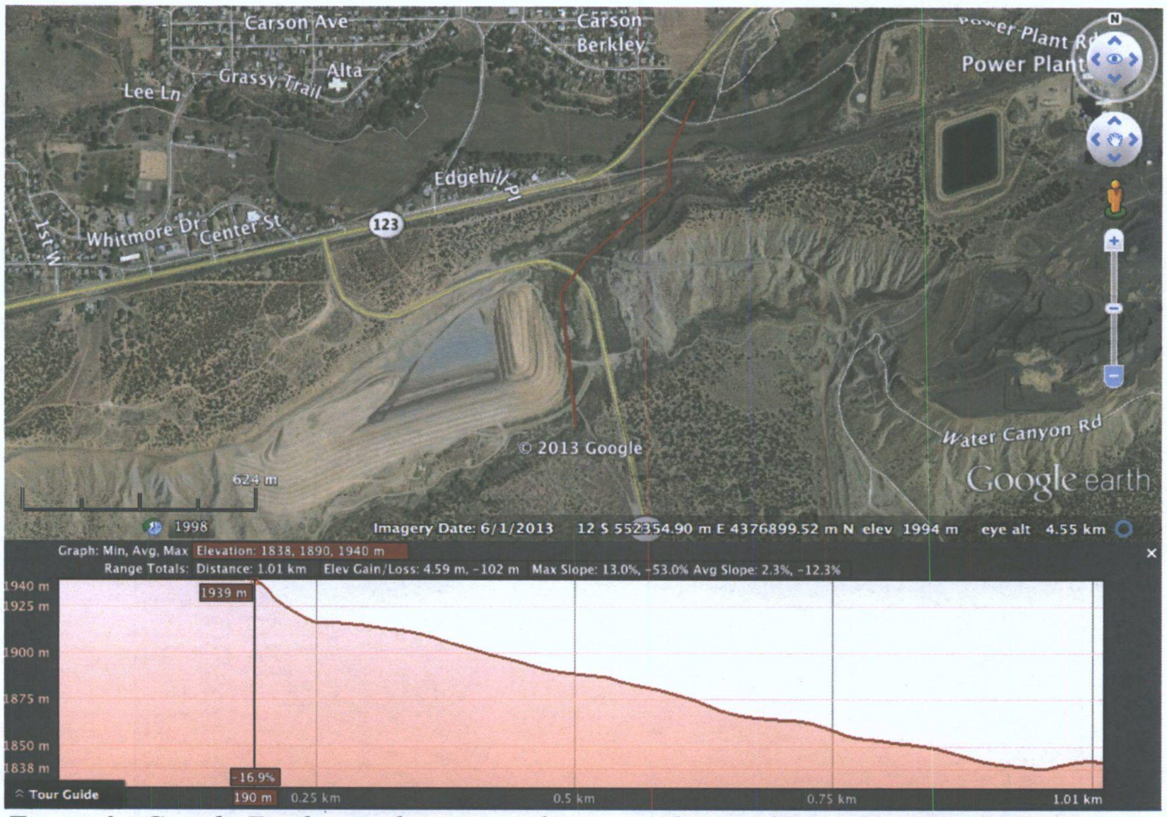

Figure 3. Google Earth aerial image and topographic profile (red) in the vicinity of SCA-1.

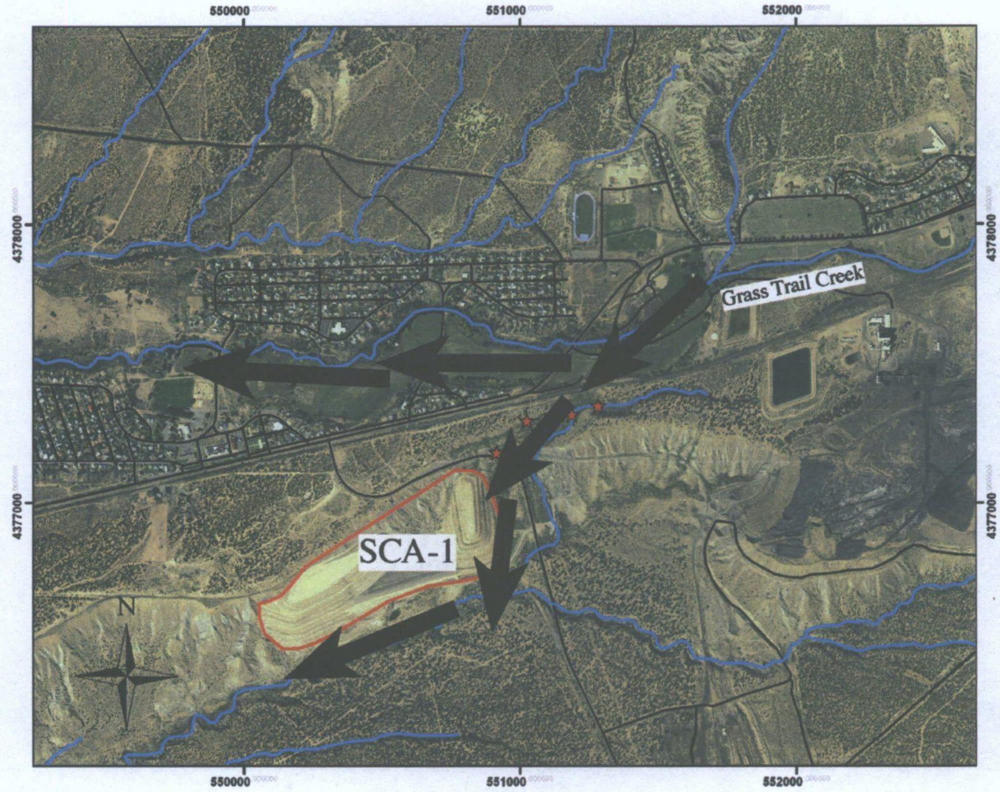

Figure 4. Map illustrating selected features of shallow groundwater flow systems in the vicinity of SCA-1. Bold, black arrows show the diversion of underflow from Grass Trail Creek along the east edge of SCA-1 and into the stream south of the landfill. Black lines show roads, blue lines drainages, and red stars seeps and springs (data from Utah Automated Geographic Reference Center, http://gis.utah.gov/data/) with orthoimagery (http://gis.utah.gov/data/) draped over the hillshade image. Perimeter ticks represent positions and distances in meters (UTM projection NAD83, Zone 12S)

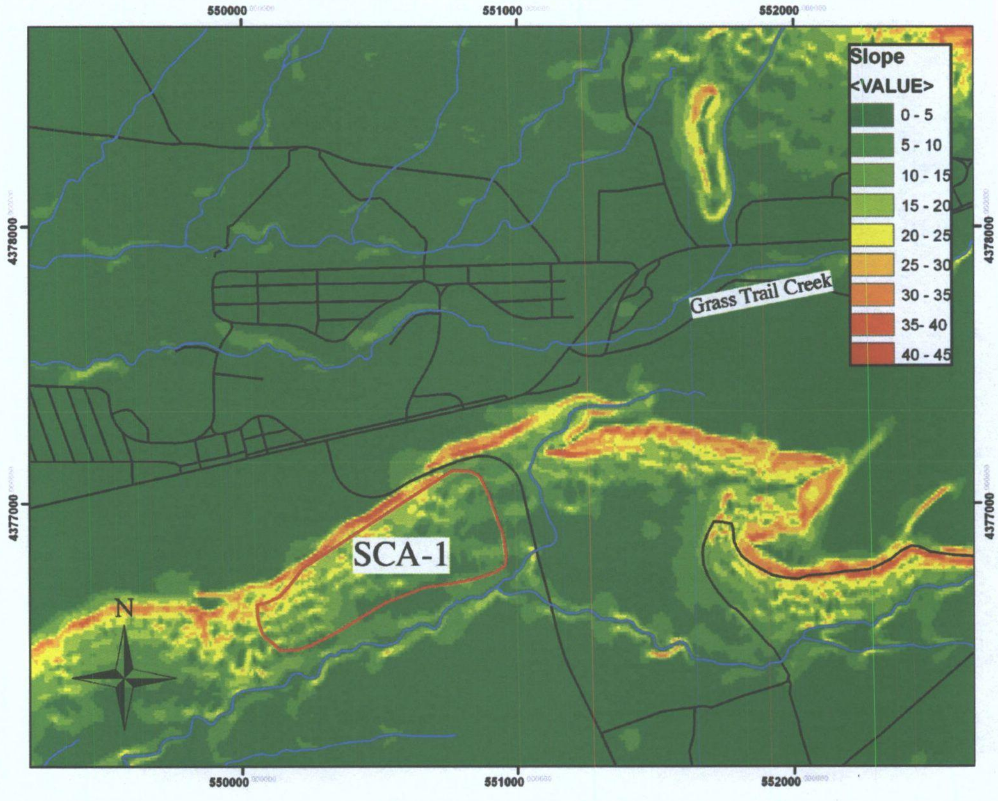

Figure 5. Slope map of the cliff into which SCA-1 is constructed. Topographic data obtained from the US Geological Survey (http://viewer.nationalmap.gov/viewer/) were used to generate slope values (in degrees; see key) using ArcMap (ESRI, v. 10). Black lines show roads and blue lines drainages (data from Utah Automated Geographic Reference Center, (http://gis.utah.gov/data/; UTM projection NAD83, Zone 12S).

Appendix: Report of Site Visit Aug. 19, 2013

On Monday, Aug. 19, 2013 I visited the towns of Sunnyside and East Carbon, Utah to inspect and photograph the SCA power plant and SCA-1 landfill in support of this report. As expected, entry to the power plant and landfill are controlled, so all inspections were made from public roads, which nonetheless afforded excellent views. Photo panoramas were taken with representative images shown and discussed below. The path of my inspection is detailed in Figure A1.

A photo panorama shows the spatial scale of the SCA-1 landfill as well as its development near and into the cliff (Fig. A2). A grader working the landfill is indicated for scale, as well as the wetland that manifests diverted groundwater flow from beneath Grass Trail Creek. This wetland could also mark the path of diverted stream flow if/when stream piracy occurs. It is already occupied by an ephemeral drainage.

Figure A3 shows a number of important details. The power plant is shown in its relationship to SCA-1 in the foreground (power plant at intermediate distance) and the Book Cliffs in the background. At its east end, the capped portion of SCA-1 is offset somewhat from the natural slope of the cliff. However, toward the west, new areas of excavation are directly on the cliff (Fig. A4). The Blue Gate Shale Member of the Mancos Formation is seen in the slopes, overlain by capping alluvium "holding up" the soft shale. Especially prominent are the diverted underflow and intermittent drainage. Here, the diverted underflow is readily apparent in the vegetation, whereas the path for the potential diversion of Grass Creek Trail is also obvious.

After inspecting the power plant and SCA-1 area, I traveled into the Book Cliffs via Whitmore Canyon, then driving up the Water Canyon Road to Bruin Point. Figure A5 is a view from the crest at an elevation of >10,000' back toward Sunnyside. With the San Rafael Swell and Sunnyside in the distance, the large system of canyons at high elevation is apparent. The high elevations provide an orographic trap for both summer monsoon moisture and winter cyclonic precipitation. Combined with the large drainage system of canyon networks that feed Grass Trail Creek, the potential for episodic flash floods is readily apparent. This provides important perspective to the SCA-1 site given the potential for stream piracy to divert flows beneath and across the landfill. Also worth noting is the potential for debris flows, which could be enhanced if wildfires were to affect this drainage system.

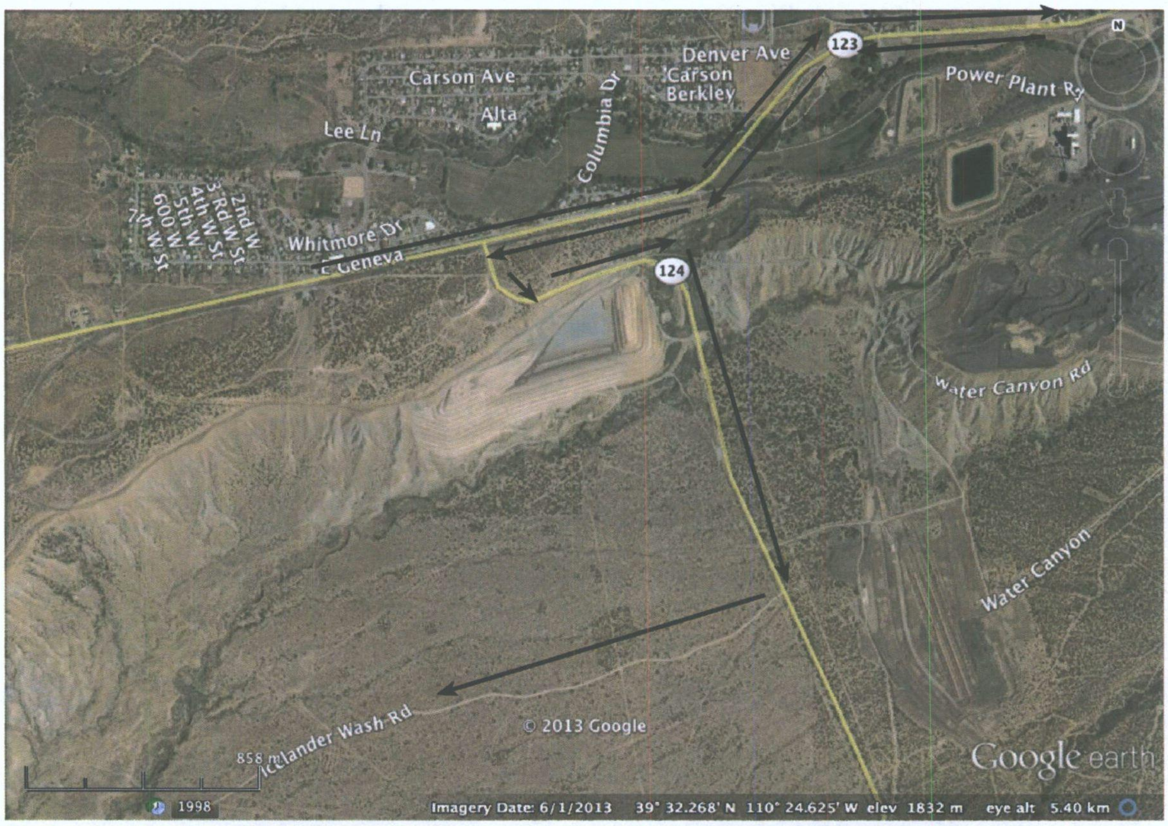

Fig. A1. Black arrows show the path of my inspection of SCA landfill and power plant area. The image was obtained from Google earth.

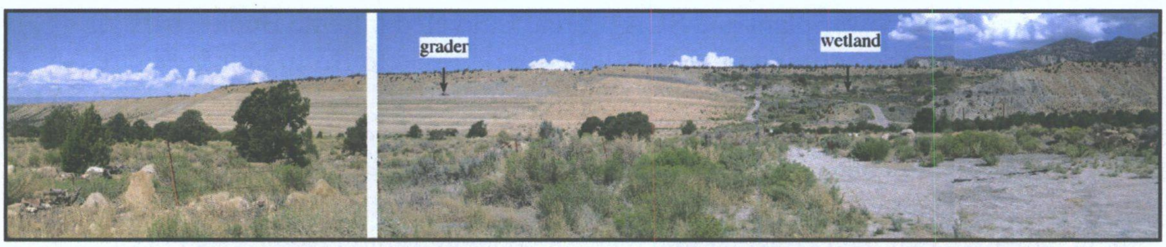

Figure A2. Photo panorama taken from Highway 124 northward toward SCA-1. A grader is indicated for scale.

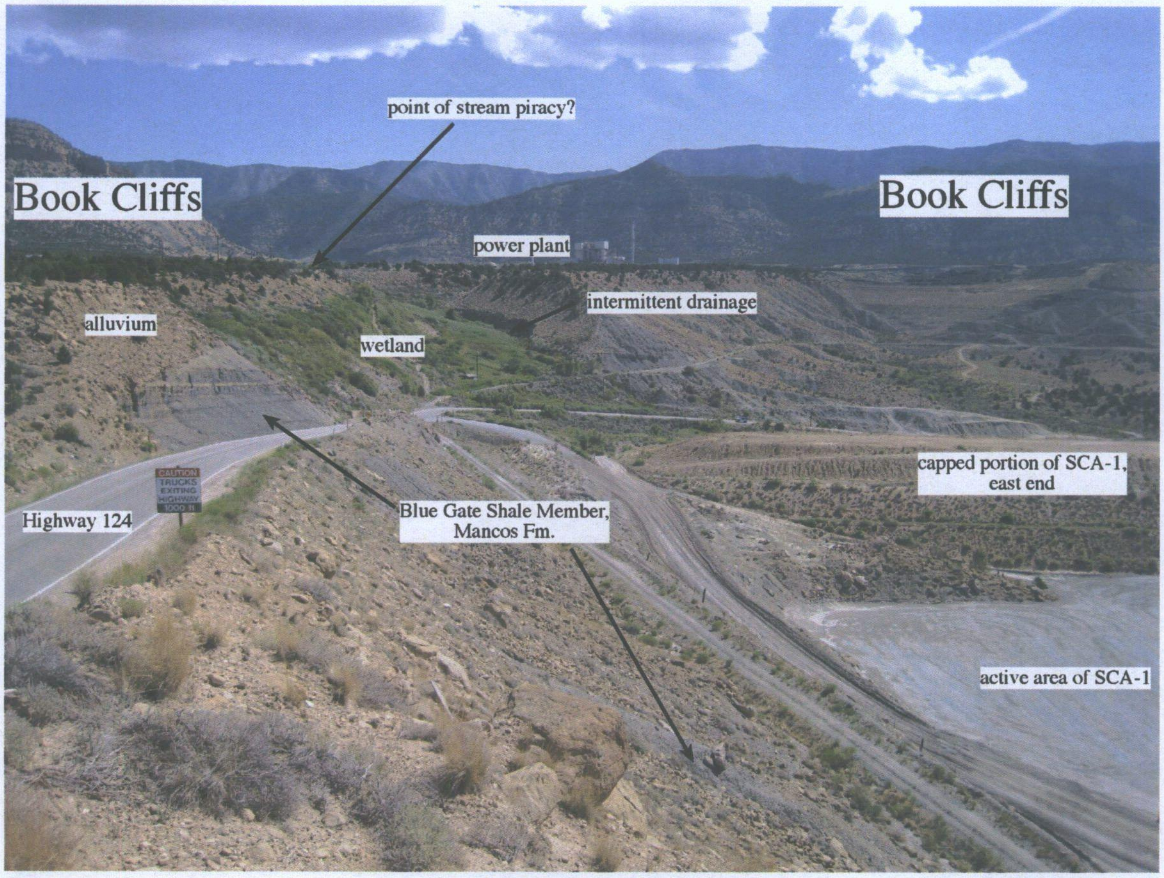

Figure A3. Annotated photograph of the east end of the SCA-1 landfill and SCA power plant. View is to the east.

Figure A4. West end of SCA-1.

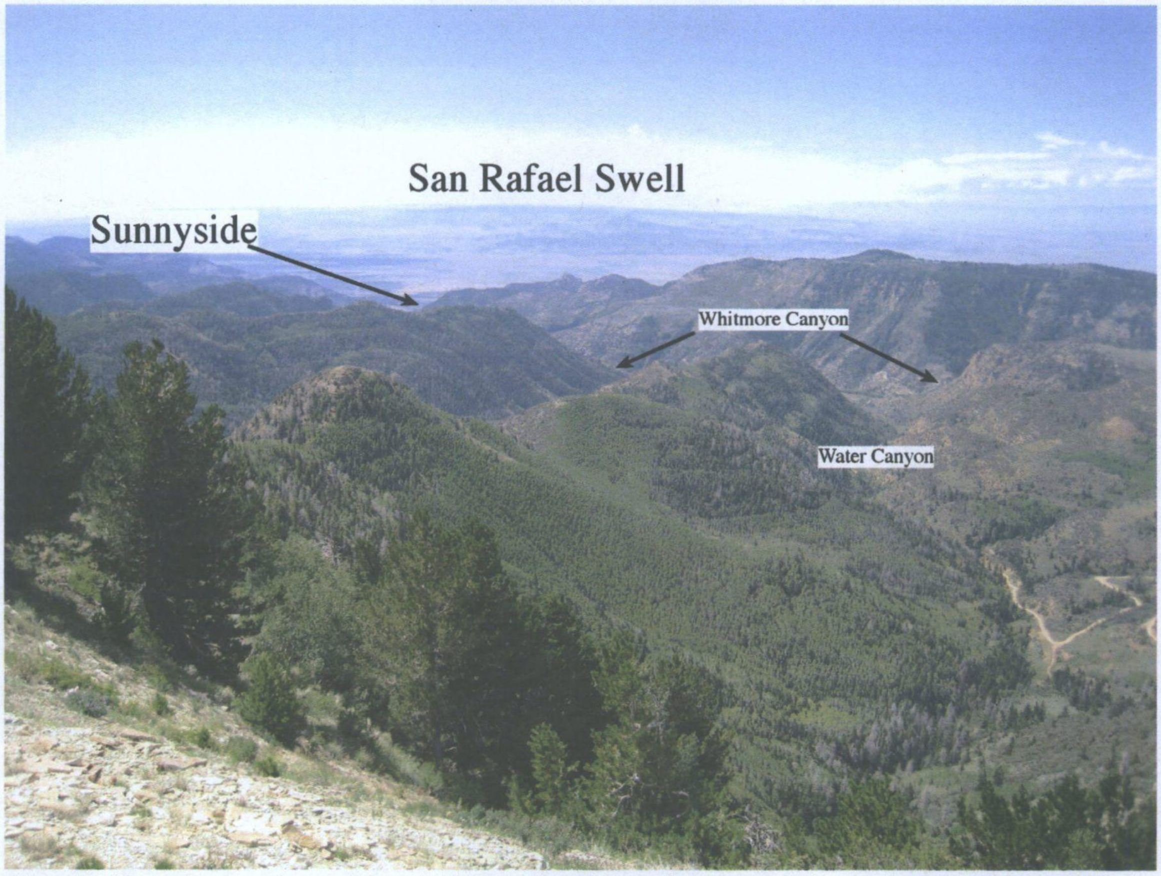

Figure A5. View to the southwest from near Bruin Point on the crest of the Book Cliffs back toward Sunnyside, Utah.

CURRICULUM VITAE

Stephen Tracy Nelson

Department of Geological Sciences
S389 ESC
Brigham Young University
Provo, Utah 84602

AREAS OF EXPERTISE

analytical geochemistry *stable isotope geochemistry, radio-isotope geochemistry, radiogenic isotope geochemistry, diatom analysis*
paleoclimatology and isotope hydrogeology
tectonomagmatic history of the Cordillera
field geology

CURRENT POSITIONS

Professor of Geological Sciences (2007-present), Brigham Young University

PREVIOUS EXPERIENCE

Associate Professor of Geology (2000-2007), Brigham Young University
Assistant Professor of Geology (1997-2000), Brigham Young University
Member, Chair, and Vice Chair, Utah State Radiation Control Board [Board membership by Gubernatorial appointment] 1998-2008 representing regulated academic institutions
Senior Staff through Project Geoscientist, Woodward-Clyde Federal Services (Mar. 1993-Dec. 1996)
Post-doctoral researcher, Department of Earth and Space Sciences, University of California, Los Angeles (1992-1993)
Material science researcher at High Pressure Technology, a subsidiary of RDA/Logicon, Los Angeles (1988-1993)

COMMITTEE SERVICE

- new faculty search committee chair, Dept. of Geology (2002-present)
- new faculty search committee, Dept. of Geology (2001-2002)
- awards committee chair, Dept. of Geology (1999-2002)
- awards /graduate admissions committee member (2002-present)
- employment specialist, Dept. of Geology (1997-2002)

DOCTORAL RESEARCH (1987-1991)

Mid-Tertiary Magmatism of the Colorado Plateau: The Henry and La Sal Mountains, Utah: University of California, Los Angeles, California

MASTER'S RESEARCH (1984-1987)

Tertiary Volcanic Rocks, Structure, and Hazards of the Geyser Peak 7 1/2' Quadrangle, Wayne and Sevier Counties, Utah: Brigham Young University, Provo, Utah

UNDERGRADUATE EDUCATION (1980-1984)

Brigham Young University, cum laude. Major in geology; minor in anthropology.

HONORS AND AWARDS

2011-2013 J. Keith Rigby departmental research award, Brigham Young University
2011-2012 Myron Best departmental teaching award, Brigham Young University
2000-2001 J. Keith Rigby departmental research award, Brigham Young University
1988-1989 Hugh Heard Fellowship, University of California, Los Angeles
1987 Elected Phi Kappa Phi
1986-1987 Union Pacific/Champlain Oil Scholarship, Brigham Young University
1985-1986 Outstanding Teaching Assistant Award, Brigham Young University
1985-1986 Kenneth Bullock Fellowship, Brigham Young University

LABORATORY FACITILITIES CONSTRUCTED OR ACQUIRED[1]

- Ortec Octete 8-channel alpha spectroscopy system and accompanying laboratory facility for U-series analysis of carbonates and waters
- Costech 4010 elemental analyzer for sulfur abundance measurements and sulfur-isotope measurements
- PerkinElmer Wallac Quantulus [ultra-low-level] and Guardian [low-level] liquid scintillation counters for ^{3}H and ^{14}C analysis
- TASK benzene synthesizer for sample preparation natural abundance ^{14}C measurements
- Distillation and electrolytic enrichment equipment for ^{3}H sample preparation
- Finnigan MAT Delta^{plus} stable isotope ratio mass spectrometer, equipped for automated analysis of H- and O-isotopes in water.
- Finnigan Delta V stable isotope mass spectrometer[2] Instrument is also coupled to a Costech elemental analyzer, permitting C and N abundance and isotopic measurements. Instrument is also coupled to a thermal conversion elemental analyzer for the analysis of H and O isotopes in diverse sample matrices, and has also been coupled to the S-dedicated elemental analyzer mentioned above.
- Conventional vaccum extraction line for stable isotope analysis of carbonate materials and sealed-tube combustion of organic matter
- Vacuum extraction line for isolation of CO_2 from atmospheric and soil gases
- Laser fluorination line for O isotopes in silicate and oxide minerals

GRANT PROPOSALS FUNDED OR PENDING

Date Submitted: Nov. 2011
Title: An Investigation of Wetlands on Mega-Landslides as Paleo-Climate Proxies, with Special Emphasis on the Timing of Past Maximum Effective Precipitation
Agency: Brigham Young University
Invstigators: Stephen **Nelson** & John McBride
Amount Requested: $19,870
Status: ***funded***

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1 Management responsibilities for most of these facilities were transferred to a professional faculty in our dept., David G. Tingey approx. Jan. 1, 2007.

2 In Oct. of 2005, the Department of Geology and College of Physical and Mathematical Sciences assisted in cost sharing [with the Dept. of Integrative Biology] for the purchase of a Finnigan Delta V stable isotope mass spectrometer coupled to a temperature conversion/elemental analyzer [TCEA] and conventional elemental analyzer for the analysis of C, N, O and H isotopes in organic matrices, hydrous minerals, as well as O isotopes in nitrate and sulfate samples. This instrumentation is housed in our laboratory and will increase our research capabilities.

Date Submitted: Feb. 2007
Title: Integrated Geophysical and Geological Investigation of Shallow Sub-surface Hydrogeology at or near Ash Meadows, Nevada: Pilot Study
Agency: Nye County, Nevada
Invstigators: John McBride, Stephen **Nelson**, W. Spencer Guthrie, Alan Mayo, & David Tingey
Amount Requested: $97,137
Status: ***funded***

Date Submitted: Jan., 2006
Title: Aquifer Segmentation and Groundwater Residence in the Central Great Basin
Agency: BYU ORCA
Invstigators: Stephen **Nelson**
Amount Requested: $16,795
Status: ***funded***

Date: Feb., 2004
Title: Aquifer Testing and Geophysical Investigations at the Midway Fish Hatchery
Agency: Utah Division of Natural Resources
Investigators: Mayo, A.L., **Nelson**, S.T., and Tingey, D.G.
Amount Requested: $11,000
Status: ***funded***

Date: June, 2002
Title: Evaluation of the Sources of Groundwater Recharge to the Midway Fish Hatchery Spring—phase IV
Agency: Utah Division of Natural Resources
Investigators: Mayo, A.L., **Nelson**, S.T., and Tingey, D.G.
Amount Requested: $5,770
Status: ***funded***

Date: January, 2001
Title: Acquisition of ^{14}C and ^{3}H counting equipment to support hydrologic, tectonic, and paleoseismic studies at Brigham Young University
Agency: National Science Foundation
Investigators: **Nelson**, S.T., Mayo, A.L., Harris, R.A., and Mabey, M.
Amount Requested: $171,316
Status: ***funded***

Date: November, 2000
Title: Evaluation of the Sources of Groundwater Recharge to the Midway Fish Hatchery Spring—phase III
Agency: Utah Division of Natural Resources
Investigators: Mayo, A.L., **Nelson**, S.T., and Tingey, D.G.
Amount Requested: $31,000
Status: ***funded***
Date: March, 2000

Title: Evaluation of the Sources of Groundwater Recharge to the Midway Fish Hatchery Spring—phase II
Agency: Utah Division of Natural Resources
Investigators: Mayo, A.L., **Nelson**, S.T., and Tingey, D.G.
Amount Requested: $16,400
Status: ***funded***

Date: March, 1999
Title: Evaluation of the Sources of Groundwater Recharge to the Midway Fish Hatchery Spring—phase I
Agency: Utah Division of Natural Resources
Investigators: Mayo, A.L., **Nelson**, S.T., and Tingey, D.G.
Amount Requested: $24,600
Status: ***funded***

Date: Spring, 1999
Title: Tectonic Evolution of the Cratonal Sequence, Santaquin Canyon
Agency: United States Geological Survey
Investigators (at BYU): Harris, R., **Nelson**, S.T., Christiansen, E.H., and Kowallis, B.J.
Amount Requested: $10,000
Status: ***funded***

Date: July, 1999
Title: Acquisition and Refurbishment of an Electron Microprobe
Agency: National Science Foundation
Investigators: Keith, J.D., Kowallis, B.J., Christiansen, E.H., Harris, R.A., and **Nelson**, S.T.
Amount Requested: $237,000
Status: ***funded***

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Nelson, S.T., and Mayo, A.L., The role of interbasin groundwater transfers in geologically complex terranes: A review: Hydrogeology Journal, ***in revision***.

<u>Publications</u>

Major, J., Harris, R., Chiang, H., Cox, N., Shen, C., **Nelson**, S.T., Prasetyadi, C., and Rianto, A., 2013, Quaternary hinterland evolution of the active Banda Arc: Surface uplift and neotectonic deformation recorded by coral terraces at Kisar, Indonesia: Journal of Asian Earth Sciences, v. 73, p. 149-161, http://dx.doi.org/10.1016/j.jseaes.2013.04.023

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STUDENTS ADVISED

Previous students:

Concepción Carreón-Diazconti: Evaluation of the ground water system in Midway, Utah, with emphasis on the spring supplying the Midway Fish Hatchery

Katherine Anderson: Contribution of local recharge to high flux springs in Death Valley National Park, California-Nevada

Reed Miner: The response of an arid ground water system to climate change, Tecopa Valley, California

Camille Durrant: A conceptual model of groundwater flow at the midway, Utah fish hatchery as constrained by geochemical, physical hydrogeological, and geophysical methods

David Alderks: Unresolved problems involving the hydrogeology and sequence stratigraphy of the Wasatch Plateau based on mapping of the Wattis 7.5 Minute Quadrangle, Carbon and Emery Counties, Utah: insights gained from a new geologic map

Jeremy Gillespie: A conceptual model of groundwater flow in Spring Valley, NV, and Snake Valley, NV-UT

Michelle Bushman: Contribution of recharge along regional flow paths to discharge at Ash Meadows, Nevada

Rachelle Hart: Isotopic evaluation of carbon dioxide in soil gas in Utah for a more accurate input variable in groundwater age determining models

Eric Parks: Analysis of electromagnetic and seismic geophysical methods for investigating shallow sub-surface hydrogeology

Currently advising Kathleen Anderson and Ryan Shurtliff
Current committee service for 5 students

TEACHING ASSIGNMENTS

PHYSICAL SCIENCE 100: general education survey course of the physical sciences
GEOLOGICAL SCIENCE 101: introductory physical geology for nonmajors
GEOLOGICAL SCIENCE 111: introductory physical geology for majors
GEOLOGICAL SCIENCE 446: applied environmental geochemistry
GEOLOGICAL SCIENCE 445: inorganic geochemistry for upper-division majors
GEOLOGICAL SCIENCE 535: contaminant hydrogeology [team taught w/Alan Mayo]
GEOLOGICAL SCIENCE 545: isotope geochemistry
GEOLOGICAL SCIENCE 491R/591R: department seminar for undergraduate and graduate students
GEOLOGICAL SCIENCE 590R: seminar on the geology of Death Valley
GEOLOGICAL SCIENCE 606: paleoclimatolgy

RECENT COLLABORATORS

Collaborator	Institutional Affiliation
Dr. Bonnie Pitblado	Utah State University
Dr. Caron Dehler	Utah State University
Dr. John McBride	Brigham Young University
Dr. Dennis Eggett	Brigham Young University
Dr. Alan Mayo	Brigham Young University
Mr. David Tingey	Brigham Young University
Dr. Ron Harris	Brigham Young University